Investigation into Outages of Electric Power Supply as the Result of Ice Storms

MASTER

September 1979

U.S. Department of Energy

Economic Regulatory Administration
Division of Power Supply and Reliability
Washington, D.C. 20461

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September 1979

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Jackson, Michigan 49201
Under Technical Support Contract EB-78-C-01-6674

U.S. Department of Energy
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FOREWORD

This report is the result of work done by Commonwealth Associates Inc. under U.S. Department of Energy Contract EB-78-C-01-6664. Under this contract, Commonwealth is to provide technical support to the Division of Power Supply and Reliability.

The accumulation of large amounts of ice on electric power distribution conductors and on trees surrounding these conductors has resulted in a number of extended customer electric power outages. Recently such outages have occurred on Long Island in New York, in the Dallas, Texas and Central Illinois areas and in the Portland, Oregon vicinity. The Department of Energy is concerned with the overall adequacy and reliability of the electric power supply, thus it has a vital interest in lengthy customer outages. Commonwealth was assigned the task of reviewing several ice caused electric power outages to provide information regarding electric utility and governmental actions which:

1. could prevent or minimize the extent of such outages;
2. could mitigate the impact of such extended electric power outages on consumers and their communities;
3. could expedite the restoration of electric service following an ice related outage.

Commonwealth's initial activity was to visit and hold in-depth discussions with representatives of six electric utilities which had recently experienced prolonged consumer outages due to ice related conditions. By contrasting the experiences described, Commonwealth identified measures and practices which had proved to be more successful, as well as those which were less effective. The narrative text in Chapters 1 thru 6 was provided by Commonwealth in response to its tasking.

The staff of the Division of Power Supply and Reliability has reviewed material provided by Commonwealth and other related information. Following this review a series of conclusions and recommendations have been developed by the Division staff.

Executive Summary

Conclusions and Recommendations

This investigative report prepared by Commonwealth Associates for the U.S. Department of Energy provides information regarding the experiences of six electric utilities which experienced extended customer outages due to the build-up of ice on both their distribution conductors and the trees surrounding these conductors. Following submittal of the Commonwealth report, a technical review was conducted by the Department of Energy staff and the following conclusions and recommendations were developed. The focus of this work was directed toward those activities which could mitigate the impacts of a future extended electric power outage.

Conclusions

The report by Commonwealth can be summarized in the following conclusions.

1. An ice storm causing significant electric power outages can occur in most any part of the United States. Only those electric utilities located in the most southern regions have the luxury of not being fully prepared to restore service following a major outage caused by an ice storm.

2. The majority of the electric power outages and most utility facility damage during the outages evaluated were caused by tree limbs which broke or sagged into electric utility overhead distribution lines.

3. Changing all overhead electric power distribution lines to underground cables so as to minimize the exposure to ice storms is not feasible because of the costs to both the utility and its consumers. Also, it must be recognized that the repair of underground cables requires more time than the repair of overhead lines.

4. The prompt dissemination of reliable information regarding the extent of the damage to the electricity supply facilities and the restoration times expected is necessary if individual customers are to take actions to minimize the impact on their living conditions and if the appropriate government agencies are to take actions to assure the public safety and health.

5. Adequate consumer information regarding the preparation for electric power supply outages is an essential element in mitigating many of the public health and safety consequences of an extended electric power outage.

6. Detailed planning among the local government agencies and the supplying electric utility can serve to lessen customer impacts and expedite service restoration.

7. The Federal government has many assets especially in the military establishment which, if available on a timely basis could serve to expedite restoration of electric service following a major interruption.

Recommendations

Based on the purposes of this report as contained in the foreword, the Department of Energy has developed the following recommendations. They are primarily directed at electric utilities since utilities have the major role in the continuity of electric service. The presence of a recommendation is not intended to imply that every electric utility has this deficiency. However, it would be appropriate for all electric utilities to review their present state of preparedness.

1. Electric utilities, both large and small, in ice accumulation areas should develop a comprehensive and well coordinated set of operating procedures for handling major electric power outages. Such a plan must be tailored to fit a particular utility's geographical location and operating situation.

2. A diligent tree clearance program should be employed by all electric utilities. A customer relations program to inform customers and request their cooperation is an essential ingredient of such a program. In areas where adequate tree clearance can not be obtained the use of insulated conductors and/or the use of special protective devices should be considered so as to protect the electric service to the major portion of the customers.

3. Electric utilities should have a program to routinely review their distribution circuit protective coordination. This program should include tap line fusing and mainline sectionalizing, so as to minimize the loads interrupted when highly exposed sections of the circuit experience a fault.
4. Electric utilities should establish a specific plan to assign appropriate staff people to provide reliable public information following on electric power outage. Both the printed and the broadcast media must be used. Communication between the utility and those media groups must receive a priority.
5. Each utility should have a plan and the appropriate facilities to answer customer telephone inquiries following a major electric service outage. Particular attention should be given to the time period between the initial outage and full utility communications mobilization.
6. Electric utilities should have a detailed customer outage classification system such that appropriate geographical and customer restoration priorities are assigned. An automated system that monitors this data can be an appropriate element of such a system.
7. Electric utilities should take the initiative to assure full and effective coordination with all appropriate local government agencies for actions to occur following a major electric power outage. A detailed plan providing for emergency and regular communications, traffic control, public safety hazard removals, fires, and other appropriate issues should be developed and maintained on a current basis.

8. The Federal government on a National basis should insure that the appropriate agreements or other documentation actions are completed such that any unique military assets (e.g., large airplanes, off-road vehicles) are available to expedite the restoration of electric service. If there are legal constraints these should be identified and appropriate action taken to eliminate such constraints.

9. The training of utility people to respond properly in an emergency situation requires the special attention of utility executive management. Appropriate plans and "dry run" exercises are an essential ingredient of the training. If there are funding, limitation for such emergency preparatory activities electric utilities should identify these to the appropriate state or local regulatory agency immediately.

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CHAPTER I INTRODUCTION AND SCOPE

During recent years, a number of electric utility systems in the United States have suffered severe damage as a result of ice storms. The consequential outages of electric power supply have caused great expense and discomfort to thousands of customers in the affected areas.

It would be useful to know the total dollar cost of a major ice storm. However, this is difficult to quantify because the effect is so widespread and diversified. In addition to the direct cost of repair of the electric system and removal of debris, there are secondary consequences in the form of lost industrial production, interrupted commercial activity, spoilage of perishable commodities, etc. It can be appreciated that the total cost of such an incident is substantial.

In any such situation, valuable lessons may be learned by a systematic investigation of conditions prior to, during, and after the event. To this end, the Division of Power Supply and Reliability engaged Commonwealth Associates to conduct an investigation into recent ice storm outages, the purpose being to determine:

1. If and how such outages can be minimized by measures taken beforehand,
2. If and how the impact on the affected communities can be mitigated,
3. If and how restoration of service to customers can be expedited.

Six electric utilities, each of which had recently experienced a severe ice storm and resulting damage, were visited to study their design practices, gather data on the severity of damage, and identify problems that may have hindered restoration efforts. Discussions were also held with public officials in the affected communities and states. Information obtained in these interviews forms the basis for the investigation, and this report presents the findings.

CHAPTER II CAUSE AND PREDICTABILITY OF ICE STORMS

CAUSE

Ice storms occur when rain falls from a warm air mass through a shallow, sub-freezing layer of air next to the ground. The thickness of the cold air layer is usually around 2000 feet, with temperatures as low as 14°F. In the warm air above, temperatures may be around 40°F. Rain drops entering the cold layer become super-cooled; that is, they remain liquid even though their temperature is below 32°F. When these drops impact on objects having a surface temperature near 32°F, they immediately freeze, forming a "glaze" or crust upon such objects.

This precipitation is commonly known as "freezing rain" and can occur almost anywhere in the United States in wintertime. Even the Hawaiian island of Maui has an average of one ice storm a year on Haleakala above the 9000 foot level. However, ice storms are most likely to occur in a band from the south-central plains northeastward to the mid-atlantic states and New England.

Typically, the thickness of the ice crust thus formed is less than one inch. However, ice buildup on relatively small cylindrical objects such as overhead wires and tree branches to depths of one to two inches, measured radially, is not unique. Needless to say, this weight of ice combined with buffeting winds which usually accompany such storms have a devastating effect.

CONDUCTIVE WEATHER CONDITIONS

Ice storms are associated with a number of different types of weather situations. The most common situation is a low-pressure area moving northeastward with a front extending eastward from its center. Air moving up from the south rises over this front, creating the warmer temperature aloft necessary for an ice storm. To the south of the front, rain will fall. Icing occurs immediately north of the front, and snow falls beyond and to the north of the icing area. As the front moves, typically northeastward, an area 50 to 100 miles wide may be swept with icing conditions.

A second weather situation which causes ice storms is a broad flow of air from the southwest ascending over a cold air mass to the east. However, the first situation described above tends to be more severe in terms of ice buildup and damage. Precipitation amounts are greater and wind speeds are usually higher, thus creating more destruction than in the latter case.

Other, more localized, meteorological conditions can also cause ice storms, usually with topography playing a decisive role. For example, in a mountainous region, cold air can be trapped in a river valley with warmer air above. In this situation, the ice storm is confined to the valley bottom. A different valley situation is fairly common in eastern sections of the United States where the valley slopes experience freezing rain while the valley bottom receives rain. This is caused by turbulent mixing such that air temperature at the lowest elevation is above freezing, while temperatures at intermediate elevations remain below freezing. An interesting event occurred on December 26-27, 1969 in the Connecticut River Valley. In the northern

sector affected by the storm, icing occurred at all elevations, while in the central area, glaze was lessened in the lee of north-south ridges. At the southern extremity, no icing occurred below 1000 foot elevations.

Near the Atlantic Ocean, another meteorological situation can cause ice storms. A cold air mass may move out over the warmer ocean and be heated by the water. This warmer air will rise and may be blown inland over sub-freezing air, setting up the temperature structure necessary for an ice storm to occur.

From this discussion, it can be concluded that a variety of atmospheric conditions can cause ice storms, and that such incipient conditions will periodically prevail over large regions of the nation. However, the actual occurrence of a severe ice storm depends upon a relatively unique construction of the atmosphere, and is therefore usually confined to relatively limited areas within the region of exposure.

PREDICTABILITY

Predictions of ice storms have traditionally been subjectively formulated by local forecasters at Weather Service Forecast Offices. However, computer-implemented forecasts have become available within the last two years from the National Meteorological Center via facsimile and teletype. These forecasts are based on Model Output Statistics developed by the National Weather Service Techniques Development Laboratory. Predictions are made twice a day for the forthcoming 48-hour period. These forecasts do not indicate the amount of icing expected, although some idea of the duration can be projected. The overall intensity can

yet be judged only subjectively from forecasts of the total precipitation expected.

Presently, forecasts of freezing rain are not highly accurate. Forecasts made 24 hours in advance are correct about 30 percent of the time. To formulate more accurate predictions, the thickness and temperature of the cold air layer near the surface would have to be determined, along with the depth and temperature of the warm air above. If the warm air layer is thin, a mixture of rain and snow will enter the cold air mass and quickly freeze before contacting surface objects. Freezing rain will occur only when the warm air layer is sufficiently thick to inject raindrops into the cold air layer.

During an ice storm on March 22-23, 1972, in Montreal, raindrops were super-cooled only 50 feet above ground. Prediction of such an event would have been extremely difficult, even by a forecaster at the scene with a fully instrumented tower.

SUMMARY

In summary, ice storms occur when raindrops fall from a warm air mass through a sub-freezing air mass near the ground. There are various weather conditions that can produce ice storms, and they can occur almost anywhere in the United States. Ice storm forecasts are not very accurate, and the severity of the storm is even less predictable, particularly with respect to localized areas.

CHAPTER III UTILITY INTERVIEWS

In order to obtain first-hand information about the effects and aftermath of severe ice storms, representatives of six utilities having recent experience with this problem were interviewed, namely:

Long Island Lighting Company
Central Illinois Light Company
Central Illinois Public Service Company
City Water, Light and Power Department of Springfield, Illinois
Dallas Power and Light Company
Portland General Electric Company

Public officials in the affected communities and cognizant state agencies were also interviewed.

Exhibit 1 following shows the respective dates upon which ice storms occurred, the extent of interruption, and other pertinent data.

In each case, the interviews were directed toward learning:

1. The foremost causes and essential nature of the damage suffered,
2. The state of preparedness and system design criteria as related to withstanding ice storm damage,

ICE STORM SUMMARY - SIX UTILITIES

<u>Utility</u>	<u>Total Number of Customers Served</u>	<u>Date of Storm</u>	<u>Number of Customers Interrupted</u>	<u>Percent Interrupted</u>	<u>Outside Repair Crews Called In</u>	<u>Storm Predicted</u>	<u>Days Elapsed To Complete Service Restoration</u>
LILCO	876,000	1/13/78	340,000	38.8	378	No	4
CILCO	179,000	3/24/78	27,000	15.1	19	No(b)	17
CIPS	296,000	3/24/78	63,000	21.3	(a)	No(b)	(a)
Springfield	131,000	3/24/78	50,000	38.2	60(c)	No(b)	14(c)
DP&L	257,000	12/31/78	75,000	29.2	180	Yes	9
PGE	441,000	1/10/79	125,000	28.3	153	No	5

(a) Data unavailable.

(b) Freezing rain was forecast, but for the following day.

(c) Estimated.

3. The adverse impacts upon the community and vital services,
4. The factors controlling the duration of the outages.

It is emphasized that the purpose of these interviews was to discover what worked most successfully in minimizing outages, mitigating the effect upon the community, and speeding service restoration. Severe ice storms are not so frequent but something new is learned whenever they occur. Many of the positive suggestions contained hereinafter were advanced by those interviewed who now have the benefit of hindsight.

The writers wish to express their appreciation for the cooperation given by representatives of the utilities and public officials in the course of the interview.

NATURE OF DAMAGE

Following is a summary of the observations drawn from these interviews regarding the cause and nature of the damage suffered by the electric systems. The experience of all six utilities would support these generalities. Information obtained from public officials generally confirmed that which was provided by the utilities.

1. There are actually two primary causes of damage to utility equipment during an ice storm. First is the weight of ice on wires, crossarms, insulators and station equipment. Second is the strong wind which frequently

accompanies the storm, and tends to precipitate breakage of ice-laden tree limbs, power line conductors, and support structures.

2. The extent and nature of ice storm damage is dependent on location. Lines in suburban areas with many trees are most susceptible to damage from falling limbs, while lines in rural areas are more susceptible to direct damage from strong winds adding to the burden of ice. This difference occurs because rural lines tend to be apart from trees, but correspondingly more exposed to the elements.
3. Line structures having a single set of conductors can generally stand more stress than those carrying one or more high-voltage circuits, and/or an underbuild of lower voltage circuits. The installation of telephone and television cables below the power circuits further increases the vulnerability of line structures to ice storm damage. This applies in both urban and rural settings.
4. A heavy coating of ice on a conductor increases its weight and causes the conductor to stretch between support points. This increased sag may cause the conductor to touch circuits or other structures installed below. If this happens, a line fuse will blow or the line will burn down. Extremely heavy ice loads can also cause a conductor to be permanently damaged by stretching beyond its elastic limit, by conductor breakage, or by separation at splices.

5. A strong wind blowing crosswise to a line during an ice storm may cause the ice to form assymetrically about the conductors, creating an airfoil. The wind acting on this airfoil may cause the conductors to swing up and down, much like a skip-rope. This is called "galloping". This motion, which may be ten feet or more in amplitude, together with the added weight of the ice, places extreme forces on poles and crossarms, almost invariably causing structural failures and downed lines where it occurs to an appreciable degree.
6. A heavy coating of ice on open-type substation equipment can cause it to become inoperable. Ice on insulators can lower their capability to withstand voltage stresses, resulting in flashovers and consequential power outages.

In the case of each utility interviewed, the damage suffered was due to one or more of the above conditions. In the case of Long Island, Dallas, Portland, and Springfield, most of the damage was from ice-laden tree limbs falling into distribution circuits and service lines to individual homes. In the more rural areas in Illinois, most of the damage was due to pole breakage in open areas, or whole trees falling into lines and breaking conductors. Photographs are included at the end of this report to convey some idea of the damage that can be caused by a severe ice storm.

EFFECTIVE PRACTICES

The American National Standards Institute has established three classes of ice and wind loading criteria for designing electric power lines, i.e., Light, Medium, and Heavy. The United States is divided into three districts on the basis of these criteria (see Exhibit 2 following). The central, mid-west, and northeast states are designated Heavy Loading Districts, while the Pacific northwest, mountain, and south-central states are in the Medium Loading District. California, southern parts of Texas, New Mexico and Arizona, together with the other southern states, are in the Light Loading District. With respect to the six utilities interviewed, those in Long Island and Illinois are in the Heavy Loading District, while Dallas and Portland are in the Medium Loading District.

The ANSI loading values are summarized on Exhibit 3. The design criteria used by all six utilities are in accordance with these ANSI standards. In addition, Portland uses the Heavy Loading Criteria in areas where difficulties have been encountered in the past.

MAP OF THE UNITED STATES SHOWING RECOMMENDED
DESIGN LOADING OF OVERHEAD POWER LINES
NATIONAL ELECTRIC SAFETY CODE, 1977 EDITION

SUMMARY OF ANSI LOADING RULES^(a)

	Loading District		
	Heavy	Medium	Light
Radial thickness of ice - inches	0.50	0.25	0.0
Horizontal wind pressure - lb/ft ²	4	4	9
Horizontal wind velocity - mph	40	40	60
Temperature - °F	0	+15	+60
Constant ^(b) - lb/ft	.31	.22	.05

(a) Recommended for use in the design of electric power transmission and distribution lines per National Electric Safety Code - 6th Edition.

(b) The conductor loading is a function of the weight of ice and conductor, the force of the wind, and the temperature. This constant is added to the resultant loading to provide additional safety margin.

NOTE: A 4/0 AWG ACSR conductor subject to the ANSI Heavy Loading Rules would be designed to withstand a total weight of 1.4 pounds per foot of conductor. The same stress would be produced by a wind of 108 miles per hour, without ice, at 0°F.

RESTORATIVE MEASURES

As a result of the interviews, the following conclusions were reached relative to service restoration procedures:

1. All six utilities experiencing the ice storms described in this report have service restoration plans which include procedures for special assignment of personnel during severe emergencies, alerting the media and public officials, and mobilization of repair crews. They also have programs to train employees for duties during an emergency.
2. They all provide emergency telephone numbers for reporting outages, have regular tree trimming programs, and have established procedures for routine maintenance and inspection of their power distribution facilities.
3. All of the utilities interviewed have mutual assistance arrangements with neighboring utilities for aid in emergencies. These arrangements include information on whom to contact to secure assistance, as well as guidelines for handling the logistics of support crew mobilization. All six have emergency kits ready to supply foreign crews with up-to-date system data and maps.
4. All utilize weather reports to warn of possible adverse conditions. However, of the storms encompassed in this investigation,

only the Dallas storm was predicted far enough in advance to make it possible to have crews on standby. This is consistent with the fact that ice storms are very difficult to predict, as discussed in Chapter II.

5. Work hours during restoration were either 16 hours on and 8 hours off, or 18 hours on and 6 hours off. Dallas Power and Light was an exception in that its crews worked around-the-clock, as did most of the foreign crews assisting in the restoration process.
6. No utility interviewed reported any difficulties in obtaining the required supplies and materials with which to repair the electric system, e.g., fuses, splices, conductors, insulators, and hardware.
7. Contract, city, and county tree trimming crews were variously called upon to assist in the removal of broken limbs and fallen trees. Their assistance proved to be very helpful.

In general, all of these provisions were effective in restoring electric service, although the speed and efficiency of the process was not always to the complete satisfaction of the utilities or their customers. As with any plan or system which is infrequently used, malfunctions, delays and inefficiencies were experienced. These are described in the following section.

PROBLEM AREAS

Following are the most troublesome areas impeding service restoration and preventing a more effective handling of community concerns, as revealed by the interviews:

1. Without exception, the interviews suggested that the most serious problem impeding restoration of service after a severe ice storm is communications, including those internal to the utility, between the utility and its customers, and with the local civil authorities.
2. Calls from customers reporting outages soon jammed the telephone facilities, and a significant number of customers called repeatedly, aggravating an already difficult situation. All of the utilities interviewed reported that public officials had difficulty contacting responsible utility spokesmen by telephone. In Dallas, the city emergency command post requested and finally obtained an unlisted telephone number with which to contact the utility. The news media generally had difficulty obtaining information from the utilities.
3. Control centers had difficulty communicating with foreign crews because of differing VHF and UHF radio frequencies. Reports from crews regarding completed repairs were often delayed, making it difficult to determine the exact status of the repair process in a timely fashion. Communication with foreign

crews was somewhat better in Dallas and Springfield because the assisting utilities brought their own base radio stations and set them up in the respective control centers. This is a practice which should be greatly encouraged.

4. Access to damaged facilities was a common problem, particularly in urban areas. Long Island Lighting Company has mainly constructed their lines on backlot property lines making it difficult or impossible to park bucket trucks near the lines. In Dallas, the lines are constructed on dedicated alleys, but fallen tree limbs had to be removed before equipment could be moved in. Springfield also reported difficulties in gaining access to damaged facilities because of fallen trees.
5. Those utilities with tree problems all reported resistance on the part of property owners to tree trimming. Long Island Lighting Company has mitigated this problem to some extent by replacing uninsulated primary voltage wires with fully insulated conductors in the areas where public resistance to tree trimming has been particularly strong. Dallas Power and Light Company had an incident in which a customer with service refused to allow trimming which would have permitted a temporary connection to his neighbor's house that was without service. Portland General Electric is attempting to solve this problem

with an intensive public education program, and has volunteered to purchase a new planting for a customer if an old tree must be removed in order to protect power lines.

6. All utilities reported problems in providing food and lodging for foreign crews. In at least one instance, the problem was aggravated when local citizens without power moved into motels and hotels that had power.
7. All of the utilities interviewed maintain some number of portable generators to be used in emergencies for temporary and partial power supply to services which are vital to the restoration of the main electric system. Some had spares which could be loaned to specially critical customers. However, the utilities have neither the quantity of generators, nor the time and manpower to install them so as to provide for any significant number of customers in the course of an ice storm. The few generators that were available had to be reserved for the most critical services. Many customers with the need to operate water pumps, sewage pumps, milking machines, refrigeration equipment, and the like encountered difficulties in obtaining, renting, or purchasing portable generators from commercial sources.
8. Three utilities reported problems with late arrival of foreign crews and their equipment. Trucks coming into Long Island from New

Jersey were barred from the tunnels and had to detour to the bridges. Dallas Power and Light had to send tire chains to some of the foreign crews, and trucks coming into Oregon from out-of-state were delayed at the state border by a vehicle license problem.

9. Three utilities requested assistance from branches of the armed forces. Long Island asked the Air Force for troop transport planes to fly in foreign crews and equipment, and were refused because regulations then in effect would not permit it. Dallas requested Army Engineer Corps units to assist in cleanup and were refused for the same reason. Portland requested and received the aid of National Guard troops, but they were slow to respond, did not have suitable equipment, and were marginally effective in providing assistance.

SUMMARY

In summary, the interviews revealed that damage from severe ice storms can be devastating, even when systems are built and maintained in accordance with accepted utility practice. This is particularly true in suburban areas with many trees adjacent to power lines. No reasonable design can prevent damage to an electric line which is impacted by a falling tree or heavy limb.

In general, the utilities interviewed believe their preventative maintenance programs and emergency procedures are basically effective, although there is a recognized need for improvements in the problem areas just described.

The most severe problems impeding restoration of electric service are inadequate communication, inaccessibility to damaged lines, and imperfect logistics for the deployment, subsistence and housing of foreign crews.

CHAPTER IV OUTAGE PREVENTION

By comparing the best and the worst of the experiences reported by the six utilities with respect to individual events on their respective systems, it appears there are four additional things which, if uniformly and diligently done beforehand, could reduce the number of outages due to ice storms. The areas of potential improvement are:

1. More frequent and more thorough trimming of existing trees,
2. Better customer information and planning in the planting of new trees, with careful consideration for ultimate growth and resistance to the elements,
3. Routine inspection and maintenance of facilities,
4. Improvement in the utilities' recording of outages and processing of the data bank to locate vulnerabilities and plan remedial measures.

The following discussion deals with these topics in more detail.

It is to be noted that no reasonable measure can totally prevent electric power outages in all weather. For example, no power line can be built to resist a toppling tree. Therefore these measures must be regarded as reducing rather than eliminating the potential problem.

TREE TRIMMING

Every electric utility undoubtedly has some program for routine right-of-way inspection and tree trimming. However, actual accomplishments along this line often fall far short of the ideal. This is because there are factors which discourage diligent tree trimming, not the least of which is pervasive public resistance. Also, tree trimming is an expensive operation, and one which tends to be deferred in order to cut costs in times when revenues are marginally adequate to meet the rising costs of providing service.

The natural course of events is this. Usually the utility power line is constructed long before the trees reach their mature outline. Certainly no utility would undertake to build a new line engulfed in trees as a matter of choice. Subsequently, trees are planted or seedlings grow until there is insufficient separation between the trees and the power line, substantial limbs obtrude over the line, or the line comes within the arc of fall of a major trunk. At this point, the utility's solution is to cut foliage and limbs back to minimize the threat. Because the public understandably dislikes and resists altering the density and symmetry of the mature trees, because rigorous tree trimming is expensive with respect to a large and widespread electric system, and because the problem worsens very gradually, all of the parties involved have great temptation to ignore the problem until there is an ice storm.

Most certainly, a utility will deserve customer resistance if their tree trimming program is too aggressive or drastic. However, customer education can greatly alleviate the problem. Customers should be advised that a well-managed tree trimming program is not only in the utility's

best interest, but theirs as well. Many things can be done by utilities to explain the cautious relationship that trees and electric power facilities must have with each other. For example:

1. Periodically (say twice a year), include information regarding tree management in power bill mailings.
2. Periodically (say quarterly), insert newspaper advertisements dealing with tree management.
3. Encourage programs to be given by qualified utility personnel or sponsored experts for the information of civic organizations, youth organizations, etc.
4. Solicit the cooperation of the state department of natural resources, city foresters, and university forestry departments so as to achieve the best possible compromises between scenic preservation and reliable power supply.

TREE PLANTING

When ice storms do occur, outages of utility lines would be much reduced if the proper types of trees were planted in the vicinity of the line. Obviously, large trees such as maples, oaks, or elms should preferably not be planted in close proximity to power line rights-of-way. Although utilities do not have the authority to dictate what kinds of trees are planted, they can provide customers with information on what types of trees can and should be planted

near power lines to reduce the risk of outages and, at the same time, enhance the features one desires in a scenic tree. The Portland General Electric Company has published a booklet that not only discusses this matter, but also provides relevant information about types of trees that are least susceptible to ice damage. It is suggested that more utilities provide similar information to their customers, with proper regard for the climatic conditions of their individual service areas.

INSPECTION AND MAINTENANCE

Virtually all utilities perform routine inspection and maintenance of their facilities, the purpose being to locate and replace worn and damaged equipment before it fails. Ice build-up can cause poles, crossarms, wire, and splices to be subjected to extreme forces. The importance of insuring that existing facilities are sound and capable of withstanding design loads cannot be over-emphasized. Facilities of questionable condition should be immediately replaced.

There are several tests that a utility may wish to include in their preventive maintenance program such as (1) ultrasonic sounding to measure the strength of wood poles at or below ground level, (2) infrared scanners to detect conductor hot-spots and weakened splices, and (3) radio wave receivers to detect corona produced by cracked or faulty insulators. In many cases, the utilities have found that these preventive measures not only improve reliability, but also pay for themselves because faulty equipment can be replaced during routine maintenance, avoiding the expense of emergency crews on overtime, and minimizing the possibility of cascading damage to other equipment as the result of the failure of one component.

RECORD KEEPING

By developing and maintaining detailed and accurate records of power system outages, utilities can determine what system components or locales are consistently subject to higher outage rates than others. The outage report should include line and substation identification, date and time of outage, equipment or facilities damaged, location and extent of damage, age of the damaged equipment, number and size of fuses replaced, status of relay targets and sequence of relay operations, estimated number of customers outaged, length of outage, weather conditions, cause of outage, occurrence of personal injuries or property damage, and any additional information available. If this information is coordinated with property records and information gathered during routine inspection and maintenance programs, data would readily be available to determine:

1. If specific types of equipment should be replaced because of poor performance,
2. If certain power lines should be re-routed because of poor performance due to geographic location or environmental factors.

It is suggested that utilities place emphasis on the above technique, since it is believed that diligent replacement of marginal facilities will avoid the occurrence of a portion of the outages, or reduce the outage period which might otherwise occur.

OTHER POSSIBILITIES

It has been said that ice storm damage could be totally or partially avoided if electric lines were placed

underground, or re-routed to avoid exposed or tree-congested areas. To be sure, undergrounding can be used to solve specially difficult problems of limited geographic extent. However, they cannot be regarded as a general or widespread solution because the expense would be prohibitive. Another disadvantage of underground lines is that if an outage or fault does happen, it tends to be of much longer duration than in the case of overhead lines. Extra time is required to locate the fault, excavate, and repair the damaged cable.

Another possibility is to build a stronger overhead line. For example, assume a distribution line were designed to withstand 4 inches of ice and a 40 mph wind. This would require stouter poles (Class H2 instead of Class 3), shorter spans (125' instead of 300') and much stronger crossarms and braces than a line designed to ANSI Heavy Loading Standards. The cost to build such a line would be seven to eight times the cost of the line constructed to ANSI standards. Thus, such construction and extra expense would be practical only where repeated or frequent ice storm damage is shown to occur. Large scale conversion to higher standards would result in a higher cost electricity all of the time in order to reduce outages due to ice storms which occur only occasionally.

SUMMARY

In summary, it appears that interruptions of electric service due to ice storms can be reduced by:

1. More diligent implementation of tree trimming programs,

2. Providing the public with information as to the best types of trees to be planted near power line rights-of-way,
3. Careful inspection and maintenance of power distribution facilities on a continuing basis, and
4. Maintaining detailed and accurate outage reports and using this information to identify and correct special system trouble spots.

CHAPTER V MITIGATION OF IMPACT ON COMMUNITY

After outages caused by an ice storm have begun, there are a number of actions which the community, the local government, and the utility can take to lessen their impact. Such steps can reduce the hardship experienced by individual citizens and speed the progress of service restoration.

DISSEMINATION OF INFORMATION

There are indications that public anxiety and discomfort is markedly heightened if the community is inadequately informed about the extent of the power outage and progress being made to restore service. The individual consumer is worried about the length of time he may be without electricity, and often uncertain about the procedures he should follow to best protect his family and property. An informed citizenry can itself assist in speeding service restoration. For example, if service interruptions and downed poles or wires are reported by the public and received by the utility in an orderly fashion, the cross-conversation could be highly beneficial in making an accurate assessment and devising a solution to repair or alleviate the situation. However, undisciplined conversations or inaccurate information are worse than none. Steps to improve communications must be initiated before the ice storm strikes. During the storm, the news media can be very helpful in reminding citizens of self-help procedures, status of the storm and repair work, and measures for correcting unforeseen problems which may arise.

Most utilities have a public relations office. Normally, one function of this office is to provide information regarding the utility's rates, future system expansion

plans, energy conservation techniques, and other information of possible interest to the public. In the event of a widespread power outage, it is strongly recommended that this office function as the prime contact for informing the public. It should be equipped beforehand to perform this function efficiently. Unpublished telephone numbers should be provided to key public officials such as the governor, mayor, chief of police, and fire chief, as well as the news media. This office should be staffed with trained utility personnel equipped with pre-recorded and pre-printed announcements, and prepared to provide frequent briefings and television interviews throughout the duration of the storm and its aftermath.

It is also recommended that the utilities provide for greatly increased telephone access during emergencies. It appears that this can often be achieved without great expenditure of money or time. For example, many utilities have Centrex telephone systems - a telephone exchange within an exchange. If the normal service-call numbers are over-utilized and other phones within the same exchange remain silent, many more calls could be handled via direct dialing to additional extensions, or by rerouting calls via the central switchboard. Pertinent information would then be received at the extra extensions and manually forwarded to the service restoration center. This would require that the utility establish a system beforehand to staff these extra telephones with qualified people drawn from their normal duties within the organization. These people must receive advance training to function effectively in an emergency.

Direct and continuous contact with the news media can also accomplish much in the way of keeping the public informed, and perhaps this will reduce the burden on the

telephone system. Through the public relations office, newspaper, television and radio should be given complete briefings regarding:

1. Magnitude of storm damage,
2. Progress of service restoration,
3. Shock hazard of downed electric lines,
4. Prevention of food spoilage,
5. Personal comfort,
6. Prevention of frozen water pipes,
7. Where to obtain emergency housing and food,
8. First aid procedures if contact is made with a downed electric line,
9. The advisability of staying indoors,
10. Telephone numbers to call for service restoration.

The above list is by no means exhaustive and serves only to demonstrate the type of information that should be provided to representatives of the media.

One way to improve communications with the news media would be to designate a special utility liaison representative who is to be easily accessible during emergencies.

This individual would be continuously informed of the situation at hand. However, a significant portion of the informative material listed above could be prepared ahead of time for release and periodic repetition during the emergency.

LOCAL GOVERNMENT ASSISTANCE

Most communities have an Office of Emergency Services whose primary purpose is to coordinate the efforts of police, firemen, and voluntary forces in the event of a natural or other disaster. There are a number of steps that can be taken by the OES to mitigate the impact of an ice storm on a community:

1. In past ice storms, some OES' have been able to locate and provide emergency generators to farmers. Such generators are not only needed to assure the general health and welfare of the farm family, but may also be required to run milking machines and refrigeration equipment.
2. National Guard Transportation Companies and "4-wheel drive" clubs have worked through OES' to provide supplemental transportation. Coordination of these units has been successfully accomplished by amateur radio operators accompanying the drivers. Such transportation can effectively:
 - a. Move emergency patients to hospitals,
 - b. Move stranded motorists and others in extreme circumstances to community shelters,

- c. Deliver food, water, or medicine to those in great need, and
 - d. Provide transport for the utility's Damage Investigators engaged in patrolling power lines.
3. Local governments should be prepared to provide community shelters. Because of the freezing temperatures associated with ice storms, many people find it difficult to stay warm and adequately fed if they remain in their own homes. Schools, churches, and other public buildings can serve as temporary housing for such individuals. Ideally, these locations will have the ability to prepare food with gas stoves. People should be encouraged to bring their own bedding and food to these establishments. The locations of emergency shelters should be pre-designated by the appropriate authorities, since attempting to do so after the occurrence of an ice storm or other disaster may prove difficult. The local government and the utility need to plan and coordinate their efforts in providing food and shelter to utility crews, medical personnel, and police or fire crews brought in to assist in the repair effort.
4. To effectively mitigate the impact of an ice storm, the invaluable utility and government personnel must be fully prepared to assume key posts without delay. Alternates should be designated for all key positions. Training sessions and seminars should be held

periodically to review individual emergency duties and to make certain that they are fully understood. If emergency service personnel are to perform effeciently under extreme pressures, they must fully understand:

- a. How specific duties mesh together to form the overall organization,
- b. The chain-of-command and responsibility for flow of information,
- c. The priorities of their assigned tasks, and
- d. The level of decision making associated with specific tasks.

SUMMARY

The impact of a severe ice storm on a community can be mitigated by implementing one or more of the following measures:

1. Maintain open channels of communication between the utility and all involved sectors of the community,
2. Provide news media and governmental officials with full and current information,
3. Establish adequate emergency telephone numbers for public officials and utility customers,

4. Plan beforehand to provide the citizenry with information regarding their personal safety, minimization of food spoilage, prevention of water pipes freezing, protection of electrical appliances from damage, etc.
5. Plan beforehand for OES and local government to provide emergency shelter, food, and transportation to those in distress, and
6. Provide advance training for all personnel who will be involved in combatting the effects of the storm.

CHAPTER VI RESTORATION OF SERVICE

If an electric utility is to restore service to customers with the least possible delay following an ice storm, there are a number of provisions which should be made beforehand. As a matter of routine, each utility should have a documented restoration plan tailored to its own specific needs. The purpose of this chapter is to discuss specific areas that should be considered in the formulation or revision of such a plan.

ASSESSMENT OF DAMAGE

In order to fully assess the magnitude of ice storm damage, an adequate number of Damage Investigators should be deployed as quickly as possible. These individuals should not be linemen who will be more useful in physically repairing the system. Rather, they should be people who have the required understanding of how the power system operates, but are normally assigned office functions in the distribution, transmission, engineering and system planning departments.

The Investigators should be assigned a territory close to their home, if possible. This will expedite their deployment and they are probably most familiar with the geography of their own neighborhood. The Investigators should be assigned as three-man teams to provide for possible absences. The territory assigned to each team will depend on population density and the nature of the transportation furnished or available.

The most important part of their training will be learning which lines in their territory are most important, and what is the best route for patrolling these lines. This training could be incorporated into a regular program. The Investigators should also be instructed in the proper clothing and footwear, since they may be expected to spend long hours in the field under adverse weather conditions.

Supplies such as maps, flashlights, flares, traffic cones, checklists, report forms, clipboards, and pencils should be assembled and stored at strategic locations in each territory. A good location may be a local substation, a school, or a community building. However, care must be exercised to prevent the Investigators from being "locked out."

To get the Damage Investigators into the field most rapidly may require that their initial transportation be their personal vehicles. However, in the event of a severe storm, utility vehicles, volunteer 4-wheel-drive vehicles, and National Guard vehicles should be assigned to provide transportation for the Damage Investigators as required.

The most critical aspect of making the Damage Investigators effective will be in providing adequate communications. As the Damage Investigators initially move into their territories, the most probable communication facilities will be the telephone and utility communications system. In a severe storm that requires 4-wheel-drive and National Guard vehicles, radio networks provided by amateur or military radio operators can be valuable in providing supplemental communications.

It is expected that the Damage Investigators can provide important information regarding the magnitude of the repair effort required and the location of:

1. Downed power lines,
2. Open switches and blown fuses,
3. Downed utility poles,
4. Broken crossarms or insulators.

The objective should be to develop a full assessment of the damage in a short period of time. Reports of the Damage Investigators should be coordinated with outage reports from customers that will be coming in simultaneously.

REPAIR FORCE ACTIVATION

Company repair forces should be first alerted as soon as the slightest potential for an ice storm is known. Exhibit 4 following gives a suggested outline of successive steps for the mobilization of repair forces, each step being geared to progressive indications of storm severity.

Advance organization of crew size is of importance to assure that available manpower is utilized to maximum benefit. Ideally, there should be a variety of crew sizes and equipment to handle different situations. For example, if the Damage Investigators have reported to the control center one or more broken poles, inefficient utilization of manpower will result if this problem is attacked by a crew consisting of only two men. On the other hand, it would be wasteful if larger crews were to attempt to deal with the many, more minor, problems such as breakage of services to individual homes. Crews should be organized for specific purposes if power is to be restored expeditiously.

EMERGENCY PROCEDURE ACTIVATION GUIDELINES

<u>Code</u>	<u>Weather Condition</u>	<u>Action Required</u>
A.	Ice storm or conditions conducive to an ice storm are forecasted	On duty system supervisor alerts Level I Personnel(a)
B.	Freezing rain reported in service territory	System operations superintendent activates Level I Personnel (Level II Personnel alerted)
C.	Outages reported or potential for outages reported by damage investigators	System operations superintendent activates Level II Personnel (Level III Personnel alerted)
D.	Severe ice damage occurring and widespread customer outages reported	Vice president of system operations activates Level III Personnel (Level IV Personnel alerted)
E.	Conditions deteriorate beyond capability of company forces and prolonged customer outages are evident	Vice president of system operations activates Level IV Personnel

(a) See Sheet 2 for definitions.

EMERGENCY PROCEDURE DEFINITIONS

- ALERT - Personnel on ALERT are on standby duty and should leave a telephone number where they can be reached. Equipment and clothing should be made ready
- ACTIVATE - Personnel ACTIVATED should report immediately to their assigned post
- LEVEL I PERSONNEL - Damage Investigators, and supervisory personnel of critical functions such as system operations, line department, customer services, public relations, district operations. The first task of these people is to ALERT the Level II employees assigned to their function
- LEVEL II PERSONNEL - Selected crews to staff critical functions and all upper management not included in Level I. The first task of these people is to ALERT the Level III employees assigned to their functions
- LEVEL III PERSONNEL - All remaining employees available to assist in emergency operations
- LEVEL IV PERSONNEL - Foreign utility crews, contract/city crews and other outside assistance

SUPPLIES

If an electrical system is to be repaired in the shortest possible time after an ice storm strikes, it is important that required supplies be readily available. Through normal inventory procedures, most companies have enough supplies to meet emergency requirements in all but the most extreme events. If any utility's requirements exceed the stores on hand, it has generally been found possible to rely on suppliers for rapid delivery of critical equipment or supplies.

SYSTEM MAPS

Sufficient copies of accurate system maps must be available if service restoration is to proceed efficiently. Such maps should be updated continuously, and should show;

1. Distribution feeder locations and numbers,
2. Switch locations,
3. Transformer locations,
4. Conductor sizes,
5. Fuse sizes and locations,
6. Feeder voltages (level and configuration)..

Ample copies of these maps must be stocked, since a major storm could interrupt electric supply to the utility duplicating facilities.

UTILIZATION OF FOREIGN CREWS

When a major ice storm occurs, a utility often cannot repair the damage inflicted on its system in a timely manner without assistance from other utilities. Through

mutual assistance agreements, a utility which has experienced major outages can request assistance from other utilities and expect to receive prompt response. Typically, a responding utility provides men, tools, and vehicles. Supplies and repair material are provided by the host utility.

If foreign repair crews are to be effectively utilized, the requesting utility should make certain that:

1. Proper food and lodging can be provided,
2. Guides are provided to each crew to compensate for lack of geographic familiarity,
3. Adequate petty cash is on hand to cover foreign crew living expenses,
4. Central rallying points are provided for foreign crew dispatch.

Numerous other factors enter into the utilization of foreign crews. Edison Electric Institute has formulated check lists to assure that these factors receive the proper attention of the utility requesting service, as well as those which respond. Check lists excerpted from the EEI Mutual Assistance Roster are included as Appendix B.

When utilities located in other states provide repair crews to assist in the restoration of electric service, these crews will use their own vehicles. It is unlikely that these vehicles will be licensed in the state of the company requesting help. Because these crews are responding to an emergency situation, most states will overlook this

technicality. However, prior planning, including advance written approvals from the appropriate state agencies, can avoid delays at border crossings and weigh stations. Public service commissions and/or state police should be advised before the vehicles cross state lines, and provided with the following information:

1. Expected maximum number of vehicles that may enter the state,
2. Vehicle types and weights,
3. Points of origin and destination,
4. Route to be driven,
5. Estimated length of work day,
6. Projected length of stay.

Interview results also show that utilities should make hotel and motel reservations for foreign crews in advance of their arrival. Extreme storm conditions will cause a shortage of lodging facilities, since all travelers will tend to seek shelter as highways become ice covered. Alternative means of lodging foreign crews in company facilities, schools, or armories may be useful in some instances.

REPAIR FORCE COMMUNICATIONS

The activation of a large work force to repair ice storm damage will necessitate large volumes of radio traffic. Information must be exchanged via radio between the restoration control center and individual repair crews regarding:

1. Magnitude and location of damage to the system,
2. Facility switching procedures,
3. Equipment requirements.

In the course of conducting the interviews for this report, it was continually noted that the large amount of information that must be exchanged tends to overburden communication facilities which are adequate in normal times. As a result, valuable time is lost and service restoration is delayed. To rectify this, consideration should be given to establishing extra communications channels and providing extra radio equipment for use in emergencies. Exhibit 5 suggests possible emergency communications channels that might be considered.

If foreign repair crews are used, the radios in their line trucks will probably operate on a frequency other than that utilized by the utility requesting assistance. To change the frequency of these radios would not be practical. It is, therefore, suggested that when foreign crews are deployed, they should be prepared to provide their own dispatcher with portable base station.

CONCEPT OF
EMERGENCY COMMUNICATIONS CHANNELS

CUSTOMER COMMUNICATIONS

When customers call to report that they are without power, they should be requested not to call the utility to offer a reminder. Experience gained in prior storms indicates that a significant number of people become impatient and call the utility again and again. This action only slows restoration attempts.

Utility repair crews should be directed to advise the dispatch office promptly after line restorations are completed. This serves as a positive check-back for record maintenance, avoids duplicate deployment of crews, and provides timely information to be relayed to the public via the news media.

ASSISTANCE FROM OTHERS

Although they cannot participate directly in repairing the electric system, local military units and public service organizations can help considerably in the restoration process by performing other valuable duties as follows:

1. National Guard personnel can be mobilized by order of state governor for the protection of life and property, after community capabilities have been expended. National Guard personnel could give substantial assistance in these areas:
 - a. Providing supplemental radio communications,

- b. Removing downed trees and branches from streets so utility repair crews can reach outaged electric facilities,
 - c. Shuttling critical parts from warehouses to field locations,
 - d. Providing traffic control and keeping sightseers away from downed lines.
2. Present laws do not permit Active or Reserve Armed Forces to provide electric service restoration assistance. Usually, this assistance can only be deployed under the following circumstances:
- a. After a state has depleted its National Guard resources,
 - b. A state of emergency has been declared by the President,
 - c. A dire local emergency exists.

Consideration might well be given to revising existing laws to permit Armed Forces personnel to assist in the event of ice storms, tornadoes, and the like, at least to the extent that it would not interfere with their primary duties. It is envisioned they could provide the same type of assistance as that outlined above for the National Guard. Also, there are special services they alone might provide, such as air transportation.

3. Local police, fire, highway, and sanitation departments can provide meaningful assistance. Police can provide crowd and traffic control. Fire, highway and sanitation departments can assist in removing tree limbs from streets and alleys to allow utility repair vehicles to work unhindered by these obstacles.
4. Contract tree trimmers have been effectively employed in past ice storms by some utilities. A coordinated plan to engage and direct contract tree trimming crews should be included as part of the utility's restoration plan.
5. Most major equipment suppliers are apparently willing to provide assistance to utilities in the event of major storm damage. Realizing the importance of selected pieces of power system equipment, local sales representatives can speed deliveries to the area where needed. Equipment suppliers have been known to take extraordinary steps to help companies return their systems to normal operation. For example, after one recent ice storm an aircraft was made available to a company to allow rapid line patrolling. Again, prior planning, including the establishment of contact points, is essential.
6. By planning the employment of aircraft rental services, lines can be rapidly patrolled once the storm is over and weather clears to an

acceptable degree, greatly aiding the restoration of customer service. The use of helicopters is desirable, since they do not require airport runway for deployment.

SUMMARY

In the event of a major ice storm and damage to an electric system, the following provisions would expedite restoration of service:

1. Rapid activation of previously established and detailed emergency plans,
2. Rapid deployment of Damage Investigators to assess the magnitude of the problem,
3. Rapid repair force organization and activation,
4. Establishment of open channels of communication with equipment suppliers,
5. An ample supply of accurate system maps for use by repair crews,
6. Utilization of supplemental repair crews from other utilities, with proper regard for their feeding, lodging, cash requirements, and guidance,
7. Encouragement of foreign repair crews to provide their own communications network, complete with portable base station,

8. Advance coordination and approval such that only notification is required to state highway authorities of the expected arrival of out-of-state repair trucks, thus avoiding possible problems related to vehicle licensing,
9. Persuasion of customers not to "remind" the utility of their outage,
10. Training of repair crews in advising the central repair office promptly when restoration of service is complete at specific locations,
11. Utilization of the National Guard, if necessary, to provide assistance by:
 - a. Furnishing supplemental radio communications,
 - b. Assisting in tree removal,
 - c. Shuttling parts from warehouses to field locations,
 - d. Controlling traffic and sightseers,
12. Utilization of local police to provide assistance in directing traffic and controlling sightseers,
13. Utilization of local fire departments, sanitation departments, and contract tree trimmers

to remove fallen trees and limbs from streets and alleys,

14. Employment of aircraft rental services to patrol lines to determine the location of damage,
15. Increased emphasis by utilities on coordinated line fusing, and marking of fuse sizes on poles or maps so a foreign crew can re-fuse without the need to wait for instructions.

The most important element in the effective implementation of all these actions is prior planning and training. Each individual involved in the restoration effort must know his assignment and be prepared to act quickly.

APPENDIX A
PHOTOS

*Lines in rural area destroyed by combination of ice and strong wind
Decatur Herald and Review, Decatur, IL*

*These conductors have been stretched beyond their elastic limit and must be replaced. They cannot be reused.
Portland General Electric*

*Broken primary lines on ground create a dangerous shock hazard
Long Island Lighting Company*

*Night restoration efforts are more difficult than during the day
Portland General Electric*

*Note tree that has fallen across roadway into power line
Long Island Lighting Company
Foreign Crew*

*Note thickness of ice on limb in right of picture
Long Island Lighting Company*

*Clutter of ice-laden trees hamper restoration efforts
Long Island Lighting Company*

*Broken tree limb must be cut away with chain saw to clear
power lines
Long Island Lighting Company*

*Crew from New Jersey assists in repairs
Long Island Lighting Company*

*Contract tree trimming crew called out to help clear trees
from lines
Long Island Lighting Company*

*Downed power line imprisons fire truck
Central Illinois Public Service Co.*

*Poles toppled by wind and ice
Central Illinois Public Service Co.*

*Multiple circuits on a line make it more susceptible to damage from ice
Central Illinois Public Service Co.*

Heavy coating of ice puts extra burden on poles, crossarms, and conductors

Jack French, Gazette-Times, Virginia, IL

*Ice storms create a lot of debris
Portland General Electric*

*Using chain saw to remove tree limbs that have fallen into
secondary circuit
Portland General Electric*

APPENDIX B
EEI MUTUAL ASSISTANCE

EDISON ELECTRIC INSTITUTE
TRANSMISSION AND DISTRIBUTION COMMITTEE
MUTUAL ASSISTANCE ROSTER

Check List #1
Information Supplied by Company Seeking Assistance

1. Name of company making the request.
2. Name and title of person calling.
3. Telephone number where requestor can be reached.
4. When the crews are needed.
5. Where the help is wanted.
6. Where the help should report.
7. The name and title of person to report to.
8. Number of crews requested.
9. Classification of crew personnel.
10. Type of emergency, rain, snow, sleet, wind, lightning, flood, other.
11. Estimated duration of the emergency.
12. Work to be done on 4 kV, 13 kV, sub-transmission, transmission.
13. Equipment needed:
 - a. Line trucks (diggers, derricks)
 - b. Passenger cars
 - c. Other trucks (service trucks, aerial ladder trucks)
 - d. Double bucket trucks
 - e. Single bucket trucks
14. Material needed.
15. Expense money to cover trip from headquarters to destination.

Check List #1 (continued)

16. Weather - present and forecast.
17. Tools required, including splicing tools and hot line tools, rubber goods, trouble lights, batteries, etc.
18. Travel conditions for transportation facilities - airport, highways, railways.
19. Suggested mode of transportation for distances greater than 300 miles. Trucks should be dispatched separately from the work forces. Mechanic to accompany if considered necessary.
20. Suggested highway routes to travel.
21. The name and title of person meeting importees at point of arrival.
22. If available, estimated time of arrival at destination.
23. Coordinate differences in time zones, standard time and daylight savings time.

EDISON ELECTRIC INSTITUTE
TRANSMISSION AND DISTRIBUTION COMMITTEE
MUTUAL ASSISTANCE ROSTER

Check List #2
Dispatching Forces to Company Seeking Assistance

1. Select Supervisor(s) who will have charge of crews.
2. Instruct Supervisor-in-Charge of the duties expected of him.
3. Decide on mode of transportation, based on weather, distance, time of day and available transportation.
4. Set up transportation details and give to Supervisor-in-Charge. If transportation distance is greater than 300 miles, consideration should be give to public transportation.
5. If trucks are required:
 - a. Select and assign drivers.
 - b. Select trucks.
 1. Line Trucks (diggers, derricks)
 2. Passenger Cars
 3. Other Trucks (service, aerial ladder)
 4. Double bucket trucks
 5. Single bucket trucks
 - c. Have trucks serviced.
 - d. Load any special tools and material if requested.
 - e. Load foul weather gear.
 - f. Assign Supervisor, to accompany fleet and consider sending mechanic.
 - g. Arrange meeting place for trucks dispatched from different locations.
 - h. Provide for expenses from home base to destination.
 - i. Arrange departure time and notify company seeking assistance.

Check List #2 (continued)

- j. Advise company seeking assistance.
 - 1. Departure time
 - 2. Approximate arrival time at designated location
 - 3. Name of Supervisor-in-Charge, number of men and vehicles
- 6. Provide Supervisor with:
 - a. Name and address of company requesting assistance.
 - b. Name, address and phone number of person he is to report to in company requesting assistance.
 - c. Conditions of emergency, i.e., rain, snow, wind, lightning, flood, etc.
 - d. Estimated duration of emergency.
 - e. Equipment needed.
 - f. Tools required.
 - g. Weather - present and forecast.
- 7. Provide Supervisor-in-Charge with check list of personal items required by employees, such as change of work clothes, personal toilet articles, shaving equipment, tool bag, (which includes climbing hooks, rubber gloves, safety belt, hard hat, etc.).
- 8. Provide Supervisor(s) and crews with money and instructions to handle required expenses.
- 9. Notify top management, through proper channels, of assistance being provided and to whom.
- 10. Provide accurate list of names and classifications of personnel in each crew and the Foreman to Supervisor-in-Charge.
- 11. Dispatch Supervisors, crew men and trucks to destination as suggested by calling company.
- 12. Provide Foreman and/or Supervisor with time slips, report forms and other required stationery supplies.
- 13. Provide crew members with authorized CIVIL DEFENSE PASSES.

EDISON ELECTRIC INSTITUTE
TRANSMISSION AND DISTRIBUTION COMMITTEE
MUTUAL ASSISTANCE ROSTER

Check List #3
For Supervisor of Crews Assisting Other Company

1. Call home office on arrival at point of emergency work assignment.
2. Verify names and responsibilities of Supervisors to be contacted at home company.
3. Verify information on where crews will be met and where they will report for work.
4. Obtain information on crew lodging and meals.
5. Check restaurant hours for proper accommodations, especially breakfast.
6. Establish daily work schedule.
7. Arrange for assignment and storing of line truck.
8. Arrange for assignment of a guide who knows the local area and who is qualified to do switching, block lines and equipment.
9. Request General Information for your crews.
10. Request Transmission and Distribution System Descriptions and Instructions for your crews.
11. Request maps of distribution circuits.
12. Request important telephone numbers such as work headquarters, System Operator, police and doctor.
13. Maintain a daily log of activities from time of departure.
14. On release from emergency, care should be taken to return all host company equipment, tools and material.
15. Turn in all outstanding unpaid bills to host company.
16. Obtain return expense money from host company.

Check List #3 (continued)

17. Arrange for return to home office in reasonable and prompt manner.
18. Report to home office when released.
19. Submit required reports to home office.